A CASE STUDY ON THE EFFECT OF DISCOURSE TYPE ON FLUENCY LEVEL IN STUTTERING

Mária Gósy[1,2] and Judit Bóna[2]
[1]Research Institute for Linguistics, Hungarian Academy of Sciences, Budapest, Hungary
[2]Department of Phonetics, Eötvös Loránd University, Budapest, Hungary
e-mail: gosy.maria@nytud.mta.hu, bona.judit@btk.elte.hu

Abstract

The present study analyzed the effects of five different discourse types (narrative, conversation, recall, reading, sentence repetition) on the fluency of a 56-year-old Hungarian-speaking, right-handed female who stutterers. The occurrences (in percentage) and durations (in ms) of filled pauses, word and part-word repetitions, and prolongations as well as the cutoff-to-repair intervals were analyzed by means of Praat software. The results confirmed that the analyzed disfluencies showed discourse type dependency where reading, sentence repetition and narrative formed one category, while recall and conversation formed another, although the connection between them is not as close as that between the discourse types in the former category. Recall seemed to be an independent category demonstrating that almost all analyzed disfluencies were either the most frequent ones or showed the longest durations in this discourse type. The interrelations of various speech planning levels were discussed.

1. Introduction

Stuttering is a multidimensional/multifactorial speech disorder that – as it is widely accepted – affects the fluency of speech (Burger and Wijnen, 1999; Curlee, 2004; Pochman and Attanasio, 2007; Craig, Hancock and Craig 2009, etc.). Although on the surface it is the involuntary fluency problem that is its most conspicuous feature, it is exactly this same feature that seems to be the most controversial (e. g., Perkins, 1995; Howell, Sackin, Glenn and Au-Yeung, 1997; Bortfeld, Leon, Bloom, Schober and Brennan, 2001; Ginsberg, 2000; Yairi, 2007). There are a variety of other factors that may influence stuttering. These are the communication situation, familiarity with the speech partner, content of the message, the linguistic complexity of the texts, emotional condition, etc. (e.g., Wall, Starkweather and Cairns et al., 1981; Bosshardt, 1997; Vasic and Wijnen, 2005; Howell, Au-Yeung, Yaruss and Eldridge, 2006). These factors have different effects on different speakers. There can be interactions among the emotional, cognitive, and linguistic factors, which in turn interact with the speech motor system (e.g., Maner, Smith and Grayson, 2000; Irwin, 2006; Blomgren and Goberman 2008; Smith, Sadagopan, Walsh and Weber-Fox, 2010).

Persons who stutter (PWS) can be recognized because they have relatively frequent disfluent episodes and specific blocks in their speech flow. Stuttering includes repetitions of sounds and/or syllables, part- or whole words, prolongations of speech sounds, avoidance of words, substitutions, or blocking of sounds

(Bloodstein, 1993; Craig, Hancock, Chang Chang, McCready, Shepley and McCaul, 1996; Craig, Hancock and Craig, 1996). The ICD (2007) defines stuttering as speech that is characterized by frequent repetition or prolongation of sounds or syllables or words, or by frequent filled pauses or pauses that disrupt the rhythmic flow of speech. It should be classified as a disorder only if its severity is such as to markedly disturb the fluency of speech.

Many disfluencies pass unnoticed or are accepted as speaker-specific characteristics in persons with normally fluent speech (NFS), although blocks and frequent part-word repetitions are conspicuous and less acceptable to listeners (Roberts, Meltzer and Wilding, 2009). Some researchers distinguish PWS from NFS on the basis of the frequency of certain types of disfluencies (Postma and Kolk, 1993). However, others claim that it is unlikely that PWS can be distinguished from NFS based solely on the number of disfluencies (Wingate, 1988; Bloodstein, 1993; Parry, 2009). As has long been known, there are many NFS people who are disfluent from time to time, but that does not make them stutterers, since blocks are extremely rare with them (Roberts et al., 2009). PWSs' speech contains a considerable amount of disfluency that also varies substantially and includes long fluent phases as well.

It has been proposed that stuttering is the result of covert detection and correction of errors in the articulatory plan (Postma and Kolk, 1993; Brocklehurst, 2008). Some researchers, while sharing this basic assumption, regard stuttering as a monitoring deficit (Lieshout, Peters, Starkweather and Hulstijn, 1993; Kolk and Postma, 1997; Vasic and Wijnen, 2005). PWS seem to detect and repair their covert errors with oversensitivity. This means that they are ready to correct possible errors before they are actually manifested. In other words, PWSs are generally able to realize that a particular word is going to cause trouble (and try to avoid pronouncing it) and so they are ready to correct even non-existing errors. Self-monitoring on the surface is signaled by two facts: halting of speech and the cutoff-to-repair interval (Levelt, 1989; Hartsuiker and Kolk, 2001; Brocklehurst, 2008). The cutoff-to-repair interval is manifested through filled or unfilled pauses providing an opportunity to plan repair. The cutoff-to-repair interval is optional, but its duration provides information about the time needed for controlling and correction of errors.

There are several models suggesting that stuttering can be understood from a multidimensional perspective, like the dynamic multifactorial models (Smith, 1997; Smith, 1999; Smith and Kelly, 1997), The Demands and Capacities Model (DCM: Starkweather et al., 1990; Kelly, 2000) or the Integrated Multidimensional Model of Stuttering (CALMS: Healey et al., 2004). Since a PWS may react to different communication situations in different ways, the processes taking place in the speech motor system may be influenced by the interacting factors, depending on the discourse types occurring in a given situation. In order to obtain objective data on the effects of particular discourse types, a PWS's, speech must be studied under natural circumstances (Tetnowski and Damico, 2001).

Spontaneous and non-spontaneous speaking tasks require different contributions from the different levels of speech planning. If an utterance that is going to be pronounced does not have to be formulated either semantically or grammatically, as it is the case in reading (Max and Baldwin, 2010), then only the lower levels are activated. Phonetic planning and execution in reading require the decoding of the written letter strings. The PWS's main problem here is that some of the speech sounds s/he has to pronounce (e. g., stops or nasals) and/or some (long) words might give her trouble. In addition, she cannot avoid certain phonologically complex words (Smith et al., 2010). Therefore, even though articulation planning may be perfect, execution may fail in some cases because of the speaker's excessive monitoring and fear of forthcoming trouble.

The speech planning processes are similar in sentence repetition; however, this task requires attention to remembering the heard sentences (Bajaj, 2007b). In this task the PWS encounters not only speech sounds and words that might be difficult for her to articulate, but s/he also has to remember the phrases heard until the articulation gestures are completed. Monitoring has to control the phonetic plan and its execution on the one hand, and controlling the exact repetition of the sentences heard according to their morphological and syntactical structures, on the other hand.

In a narrative, all of the processes of the speech planning mechanism must be activated. The speaker has to cope with his/her own thoughts and has to select those that s/he intends to share with the interlocutor. The selection of thoughts, their formulation into grammatical forms, phonological and phonetic planning, as well as pronunciation are in progress almost at the same time (e.g., Levelt 1989; Bajaj, 2007a). Speech production planning is supposed to focus, in this case, on the higher level processes rather than on those at the lower levels. The operations at higher levels of encoding are thought to be responsible for some difficulties in the PWS's speech (e.g., Ratner, 2005).

Spontaneous speaking during a recall task (e.g., Scott et al., 1995; Polyna et al., 2009) seems to require all those processes that contribute in the other four discourse types. The speaker has to interpret the story s/he has heard. Memory traces have to be recalled successfully in order to retell the story and to use appropriate grammar and vocabulary (as in the other two spontaneous discourse types). Self-monitoring also requires permanent comparison of what the speaker has recalled with the facts of the original story.

Conversation, as a discourse type, is similar to narrative: all of the processes of the speech planning mechanism are active (e.g., Logan and Conture, 1995). However, the speaker – as one of the participants in the speech situation – has to co-operate with the other speakers. Although a speaker in a conversation is not expected to speak continuously for a long time, as happens in a narrative, s/he has to integrate his/her own thoughts with the reactions of other speakers. The speaker has to observe the flow of conversation and has to make plans when and how to join in or interrupt ongoing speech. Self-monitoring is responsible for all these processes, including subsequent corrections relating to content, grammar or pronunciation.

In sum, the speech planning characteristics of different discourse types suggest that they might have an effect on the fluency level of a PWS's speech. We assume that this effect can be identified by analyzing various types of disfluencies in speaking. Spontaneous speech is full of disfluencies, such as filled pauses, repetitions, false starts, prolongations, etc., signaling the speaker's difficulty during speech planning (e.g., Levelt, 1989; Fox Tree, 1995; Shriberg, 2001; Bortfeld et al. 2001; Gósy 2003; Watanabe et al., 2008).

Our understanding of stuttering implies that the speech task required in different discourse types has a significant impact on the PWS's speech, according to the multifactorial models (mentioned above). We think that this impact is shown on the surface by the diverse numbers of occurrences and diverse durations of disfluencies, which are dependent on discourse types. A limited number of studies suggest discourse type dependent characteristics of the disfluencies mainly in children who stutter (e.g., Trautman et al., 1999; Logan et al., 2011). Results of a recent study with PWS from neurogenic origin supported the effects of various speaking tasks on their speech (Tani and Sakai, 2011).

The purpose of this study was to investigate whether or not the characteristics of four types of disfluencies in a Hungarian-speaking PWS were dependent on discourse type. Filled pauses, prolongations, part-word repetitions and word repetitions were analyzed in a PWS's speech – disfluencies that also occur in NFS's speech. Our intention was to learn whether the various discourse types (narrative, recall, conversation, reading and sentence repetition) affect the occurrence and temporal properties of the four analyzed types of disfluencies. In addition, we wanted to obtain information on possible differences in the control processes for part-word repetitions and word repetitions by analyzing the durations of their cutoff-to-repair intervals in various discourse types.

We hypothesize that the occurrence and temporal patterns of the disfluencies in the PWS's speech will be affected by the different speaking tasks presented by the analyzed discourse types. We assume that the duration needed for control in part-word repetitions and word repetitions would also be discourse type dependent. The importance of such a study lies in its ability to provide measured data on the effect of discourse types on a PWS's speech.

2 Subject, method, material

2.1 Subject

In this paper we report on a 56-year-old, Hungarian-speaking, monolingual, right-handed female PWS with a history of clinically diagnosed developmental stuttering. She started stuttering at the age of 3. Up to that age her first language acquisition was typically developing. She was a severe stutterer according both to the Hungarian Classification Scale of Stuttering and the Stuttering Severity Instrument SSI-3, and she regards herself as such (Lajos, 2003; Riley, 1994, respectively). She had no hearing, neurological, mental, speech or language deficits (other than stuttering). She had no reading problems.

2.2 Speech material and measurements

A total speech sample of 1.2 hours was audio recorded with the subject in a sound proof chamber at the Phonetics Laboratory of the Research Institute of the Hungarian Academy of Sciences. For recordings, a unidirectional high-quality microphone and Goldwave software connected to a computer were used. The speech samples were recorded following the Spontaneous Speech Corpus of Hungarian (BEA) protocol. All the discourse types involved presented the speaker with a different task. From each spontaneous discourse type, we selected a sample that was approximately 10 minutes long and began 8 minutes after the start of the recording. The speech sample was representative of the patient's usual speech pattern (see Van Borsel and Taillieu, 2001). The measured speech samples contained: 1961 syllables (553 words) in narrative discourse, 2164 syllables (571 words) in conversation, 2186 syllables (597 words) in recall, 1287 syllables (243 words) in reading and 1181 syllables (213 words) in sentence repetition. Hungarian has many long words in spontaneous speech as a result of its agglutinative character (frequently up to 7 or more syllables with a mean of about 3.5 syllables).

The discourse types were narrative (the participant was asked to speak about her life, family, work and hobbies); recall of an orally presented story (the participant was told a story and was asked to summarize what she had heard); conversation (only the participant's speaking turns were considered; the topic was job openings for young graduates); sentence repetition (22 well-formed sentences of various lengths were compiled for repetition, containing 9 to 15 words / 19 to 36 syllables); and reading (the participant was asked to read aloud a popular scientific text without rehearsal).

The durations of 913 filled pauses (in other word hesitations), 287 prolongations, 215 word repetitions and 335 part-word repetitions were found in the speech sample and analyzed. The two authors encoded and measured the disfluencies separately and, in cases of rare disagreement, two other phoneticians were consulted. Filled pauses were defined as disfluencies occurring between two different words with or without a preceding and/or following unfilled pause. Prolongation arose with vowels and also with consonants, particularly if they were continuants. The occurrences of all these disfluencies and the durations of filled pauses and prolongations were analyzed. In the case of repetitions, the durations of words in both the first and the second production were measured. The duration of cutoff-to-repair intervals in word repetitions and part-word repetitions were measured. Vowel duration was measured between the first and last glottal pulses of the vowels, while that of the consonants was measured according to their acoustic structure. The duration of the cutoff-to-repair intervals was measured from the interruption point to the onset of repair. All the measures were conducted across both the fluent and the stuttered periods of the speech samples (without any selection).

The digital recordings were submitted to acoustic-phonetic analysis (Praat software: Boersma and Weenink, 2004) using a 44.1 kHz sampling rate with a 16-bit resolution. To test statistical significance, analysis of variance (one-way ANOVA), Tukey's post-hoc tests, the Kruskal-Wallis test, and hierarchical cluster analysis were used, as appropriate (SPSS 14.0). The confidence level was set at the conventional 95%. Hierarchical clustering is a type of cluster analysis based on the assignment of a set of observations to subsets called clusters.

3. Results

The five different discourse types used in the research involved different communication tasks, and consequently different speech planning processes and probably different types of self-monitoring. In sentence repetition and reading the speaker was presented with semantically and syntactically ready-made sentences, so it was only articulatory planning and execution that required attention. This means that her task was simplified compared to spontaneous talking. The tasks of telling a narrative, taking part in a conversation and recalling a story required the use of higher speech planning levels. These are more complex tasks than reading and repetition. The two examples below have been selected from the narrative task: the first one (1) exemplifies a relatively disfluent production, while the second one (2), a relatively fluent episode within the speech sample. The various types and forms of disfluencies have been marked in bold. Prolongations are indicated by double letters, and the letters ***ö***, ***öm***, ***ööm***, ***öhm*** demonstrate filled pauses.

(1) ***ööm a öm a öhm ö s ö s*** *sport kapcsán eljutottam oda* ***hogy hogy ö ööm***
erm *the* ***em*** *the* ***erm em s em s*** *sport in connection I got there* ***that that er erm***

hogy hogy öm *egy* ***ö*** *bi**zz**onyos* ***öhm ö öm*** *társaságban* ***ö ööm***
that that erm *an* ***er*** *cer**tt**ain* ***erhm er em*** *company* ***er erm***
'in connection with sports I achieved that in a certain company'

The more disfluent episode contains filled pauses of various forms, word repetition (*hogy hogy* 'that that'), part-word repetitions (*s s sport*) and prolongations (*bi**zz**onyos*).

(2) *tehát biztos hogy ebbe az én véleményembe ez is benne van na most én ha*
so it is certain that in this my opinion this is also in it well now I if

ilyet hallok ***akkor akkor ö*** *döbbenek meg*
such I hear ***then then er*** *get shocked*
'so it is certain that this also plays a part in my opinion well now if I hear such a thing then I feel the shock'

This other episode is similar to a NFS's speech sample. It contains an *ö* type filled pause and a word repetition (*akkor akkor* 'that time that time').

3.1 Filled pauses

Filled pause is one of the most frequent disfluencies in spontaneous speech: its primary function is to provide time to surmount difficulties in speech planning (e.g., Shriberg, 2001; Gósy, 2003; Watanabe et al., 2008). In Hungarian, filled pauses in most cases involve the use of a vowel-like sound of varying length close to [ø] or the neutral vowel [ə] (see Horváth 2010). Most of the 913 filled pauses were articulated with this neutral vowel. The frequency of filled pauses showed remarkable differences across discourse types. They occurred rarely in reading (5.9/minute) and in sentence repetition (10.5/minute), while considerably more frequently in conversation (20.1/minute), in narrative (26.7/minute) and in recall (27.4/minute). By way of comparison, an average of 3.82 filled pauses per minute was found in Hungarian-speaking NFSs, with wide individual differences ranging from 0.8 to 9.5 per minute.

The mean duration of all filled pauses was 309 ms which is almost the same as that found with NFSs (307 ms on average, see Horváth 2010). The longest filled pauses were found in recall (mean: 349 ms, SD = 255.95), while shorter ones occurred in sentence repetition (mean: 312 ms, SD = 180.89), in narrative (mean: 294 ms, SD = 205.42), in conversation (mean: 284 ms, SD = 210.82) and in reading (mean: 221 ms, SD = 148.12). Since the data were not normally distributed, they were transformed into a logarithmic scale. One-way ANOVA was used on these data, and statistical analysis revealed significant differences depending on discourse type ($F(4,912) = 3.436$, $p = .008$), see Fig. 1. The post-hoc Tukey test showed significant differences between recall and the three other discourse types, reading ($p = .019$), narrative ($p = .043$) and conversation ($p = .021$).

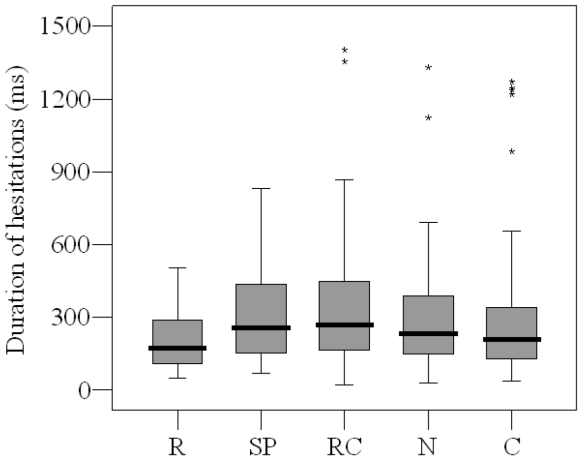

Figure 3.1. Durations of filled pauses across discourse types (median and range). (R = reading, SP = sentence repetition, RC = recall, N = narrative, C = conversation.)

The occurrences and the durations of filled pauses showed a close relationship in our PWS's spontaneous speech samples. The more frequent the filled pause, the longer its duration (e. g., in recall) and vice versa; the less frequent its occurrence, the shorter its duration (e. g., in conversation).

3.2 Prolongations

Although this type of disfluency is regarded as one of the primary symptoms of stuttering, it occurs in NFSs' speech as well, and the occurrence of various prolongations here is about 1.5 incidents per minute in Hungarian speech (Bóna and Imre, 2010). The occurrence of prolongations in our PWS's speech samples was most frequent in recall (9.22 per minute) and in sentence repetition (8.8 items per minute), while it occurred less frequently in reading (6.37 per minute) and in narrative (5.29 per minute). The least frequent occurrence was found in conversation (3.1 per minute).

Although several consonants were involved in the prolongations, most prolonged speech sounds involved vowels, particularly those in the definite article (*a/az*). Where prolongation occurred, it affected the initial speech sounds of words: in 95.5% of all cases in recall, and in 93.4% of all cases in conversation. Prolongation occurred on the first speech sound in 84.2% of all cases in sentence repetition, in 75% of all cases in narrative and in 67.7% of all cases in reading. The next most frequently prolonged speech sounds turned out to be word-final sounds (11.18% of the total). The most frequently prolonged last sounds were found in reading (22.6%), then in narrative (13.5%) and somewhat more rarely in sentence repetition (10.5%). The occurrence of last sound prolongation decreased significantly in conversation (6.6%) and in recall (2.7%). Prolongations rarely appeared on the second or third sounds of words (about 11% of all incidents in all discourse types) while somewhat more frequently on sounds close to the end of words (about 17%).

Prolongations appeared in content words in 41.0% of all cases in narrative, in 16% in recall, in 38.7% in reading, in 33.9% in sentence repetition, and only 3.3% in conversation. The proportions of prolongations occurring on content words in spontaneous speech samples were lower in our PWS (21% on average) than those obtained with NFSs, where prolongations in content words averaged 51% (Bóna, 2008). Prolonged speech sounds seem to be more characteristic of narrative, reading and sentence repetition compared to recall and conversation in our PWS's speech.

The durations of prolongations seem again to depend on discourse type (in reading: 355 ms, SD = 134.83, in sentence repetition: 402 ms, SD = 203.40, in recall: 402 ms, SD = 203.40, narrative: 314 ms, SD = 111.37 and in conversation: 467 ms, SD = 209.91). The longest prolonged speech sounds occurred in conversation, while the shortest ones in the narrative. The durations of prolongations exceeded 1000 ms in recall, in conversation and in sentence repetition (the longest prolongation was 1210 ms in conversation, 1346 ms in sentence repetition and 1456 ms in recall). There were no significant differences in the prolongation durations across discourse type. The duration of the prolonged sounds in NFSs' spontaneous speech ranged between 150 and 600 ms, with a mean value of 320 ms (Bóna, 2008). These data correspond to our PWS's values in narrative (mean: 314 ms, SD = 111.37).

The interrelations between occurrence and duration showed that prolongations were least frequent in conversation, but their durations were the longest here. They were both relatively long and frequent in narrative, while relatively less frequent and shorter in recall. Sentence repetition and reading occupy an intermediate position concerning the interrelations of occurrence and duration (Fig. 2).

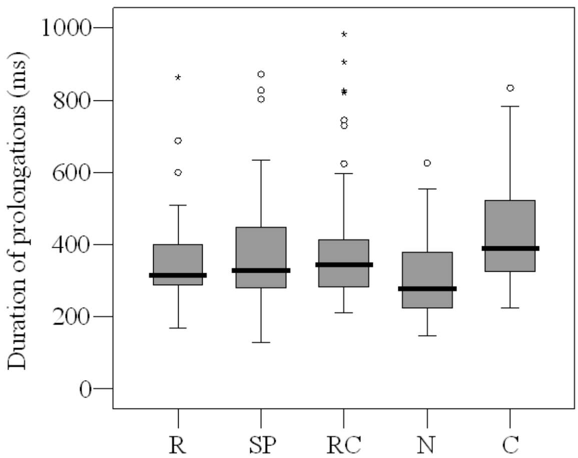

Figure 3.2. Durations of prolongations across discourse types (median and range). (R = reading, SP = sentence repetition, RC = recall, N = narrative, C = conversation.)

3.3 Word repetitions

Howell (2007) divides fluency failures into two classes (called 'stalling' and 'advancing') where stallings are characterized by repetition of one or more words. He claimed that repetitions were usually function words and that repeated simple words often preceded more complex words (Howell, Au-Yeung and Sackin, 1999; Howell and Dworzynski, 2005). Our data fully supported this claim: there was only one content word repeated – the word *legfontosabb* 'most important' – in the whole of our speech material. The proportion of function words in repetitions was 99.75%. The dominance of function words might also be attributed to the (already mentioned) fact that content words are relatively long in Hungarian and the speaker does not want to spend extra time repeating long words (function words contain generally one or two syllables). Besides, in non-stuttered speech, the proportion of function words in repetitions is also high, 92.9% (Gyarmathy, 2009).

The occurrence of repetition is heavily dependent on discourse type. There were almost no repetitions in reading (1.08 per minute) and in sentence repetition (0.74 per minute). The increase in the number of repetitions in the spontaneous speech samples was evident: it was 5.07 per minute in recall and 5.87 per minute in narrative. The highest frequency of repetition was found in conversation (7.83 per minute). For comparison, the proportion of repetition in non-stuttering spontaneous speech was 1.43 incidents per minute.

The repeated words were expected to be shorter than the first-articulated ones (Shriberg, 2001). However, our data did not confirm this assumption. There was almost no difference between the durations of the first and second words in sentence repetition and in narrative. The duration of the second word was about 20 ms longer in conversation (Table 1). There was a remarkable difference between the durations of the first and second words in recall, where the second words turned out to be 46 ms longer on average. The durational difference between the first and second words was significant in the case of recall (one-way ANOVA: $F(1, 121) = 6.184$, $p = .014$).

Table 1. The durations (mean and range) of the repeated words across discourse types.

Discourse type	Duration of words (ms)			
	First articulation		Second articulation	
	Mean	SD	Mean	SD
Reading	133	57.85	144	51.20
Sentence repetition	125	95.48	119	45.14
Recall	247	89.05	293	139.32
Narrative	240	108.27	250	95.26
Conversation	224	125.05	242	141.88
Total	230	110.89	253	130.13

The difference between the durations of the first and second words in all three spontaneous speech samples was 24 ms on average, and the difference in length between the second and first words amounted to a total of 73 ms (Fig. 3). The average duration of second words in non-stuttering speech (261 ms, see Gyarmathy, 2009) and in our participant's speech (253 ms) was very similar; however, the duration of the first words was much greater. The mean duration of the first words was shorter in our PWS's articulation (230 ms) as opposed to the mean value found in non-stuttered speech (289 ms).

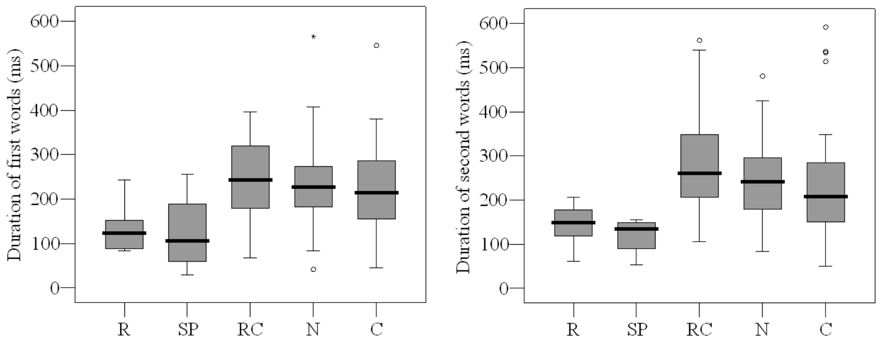

Figure 3.3. Durations of first (left) and second words (right) in repetitions across discourse types (median and range). (R = reading, SP = sentence repetition, RC = recall, N = narrative, C = conversation.)

3.4 Part-word repetitions

The category of fluency failures labeled advancings by Howell (2007) includes repetitions in which only the first part of a word is reproduced. Howell suggests that it is typically content words that are affected in such repetitions, since function words are generally easier to articulate. In our speech samples, content words accounted for 91.4% of all part-word repetitions in sentence repetition, for 78.6% in reading, for 72.3% in narrative, for 63.8% in recall, and for 48% in conversation. The relatively low proportion of part-word repetition of content words in conversation may be due to the fact that in this discourse type, the speaker can plan their words freely and has more time to do so (in contrast to narrative), while others take a turn. Fewer part-word repetitions of content words occur in NFSs' speech: our PWS's percentage in the spontaneous speech samples was 61.36%, while the corresponding value in non-stuttered speech was 40.21% (Gyarmathy, 2009).

Across all discourse types, our PWS frequently checked her articulation after producing one or two speech sounds. The proportion of those cases when the speaker interrupted her articulation after one syllable did not show much difference across discourse types, while interruptions after two syllables occurred relatively frequently in conversation (22.7%). Altogether, there were few examples for interruption after three and four syllables in recall and in reading (0.7% and 1.6%).

On average, 8.14 part-word repetitions per minute occurred in our PWS's speech samples. Her spontaneous speech samples contained 6.04 disfluencies of this type per minute, while sentence repetition contained 11.4 per minute and reading 11.19 per minute. Part-word repetition was much less frequent in recall (7.89 per minute), in narrative (4.04 per minute) and in conversation (6.2 per minute). The frequency of this disfluency in NFSs' spontaneous speech was reported to be 0.32 per minute (Gyarmathy, 2009).

3.5 Analysis of cutoff-to-repair intervals

The duration of cutoff-to-repair intervals in word repetitions showed large differences mainly in the three types of spontaneous speech samples (in narrative: 117 ms, SD = 129.95, in conversation: 210 ms, SD = 244.04, in recall: 214 ms, SD = 180.52, in reading: 116 ms, SD = 95.92, in sentence repetition: 129 ms, SD = 77.01). The longest cutoff-to-repair intervals were found in recall and conversation, while the same durations in reading, in sentence repetitions and in narrative were about 100 ms shorter than those in the two former discourse types (Figure 4). Statistical analysis revealed significant differences based on discourse type considering only the spontaneous speech samples (Chi-Square = 11.791, p = .003). Our data confirm that the durations of the cutoff-to-repair intervals of spontaneous speech samples are shorter than those reported for non-stuttering speech (Gyarmathy, 2009). The mean value of the cutoff-to-repair intervals of our PWS was 180 ms, while the mean value for NFSs' speech was 277.4 ms.

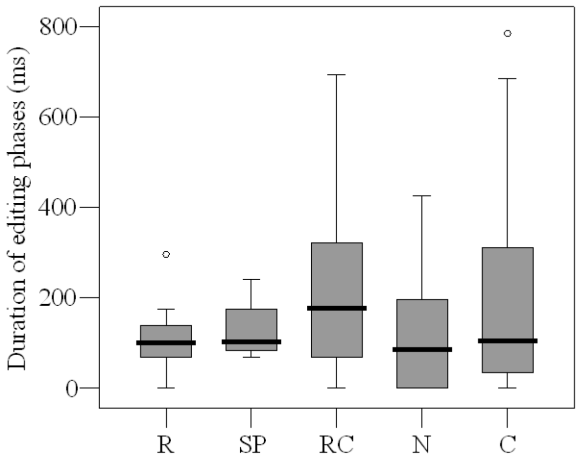

Figure 3.4. Durations of cutoff-to-repair intervals between the repeated words (median and range). (R = reading, SP = sentence repetition, RC = recall, N = narrative, C = conversation.)

The average value of durations of the cutoff-to-repair intervals in part-word repetitions in our PWS's speech samples (considering all discourse types) was 170 ms, while the mean value of her spontaneous speech samples was 192 ms (in conversation: 130 ms, SD = 148.81, in recall: 157 ms, SD = 272.33, in narrative: 288 ms, SD = 381.69, in sentence repetition: 139 ms, SD = 163.72, and in reading: 185 ms, SD = 220.31), see Figure 5. The longest cutoff-to-repair intervals were found in narrative, with a mean value of 288 ms. The same duration was about 100 ms shorter in reading (with a mean value of 185 ms). None of the remaining discourse types showed any large differences. Since the data were not normally distributed, the Kruskal-Wallis test was used, which confirmed the significant differences based on discourse type (*Chi-Square*: = 11.431, p = .002). The mean value of the cutoff-to-repair intervals of our PWS was 170 ms, while the mean value for non-stuttering speech was 152 ms (Gyarmathy, 2009).

The disfluent speech flow of a PWS is the end product of several processes that interact in a complex way (Healey et al., 2004). Therefore all measured temporal data of the discourse types were used in a hierarchical cluster analysis (see also Schwartz and Conture, 1988). The goal of this analysis was to highlight the possible connection of discourse types as the result in terms of temporal data in the case of our PWS. Hierarchical cluster analysis was carried out taking into consideration all the analyzed parameters (see the similar application of the analysis in Gahl, 2008). The results show (Figure 6) that reading, sentence repetition and narrative form one category. Recall and conversation form another, although the connection between them is not as close as that between the discourse types in the former category. Recall shows the greatest distance from other discourse types: this is almost an independent category.

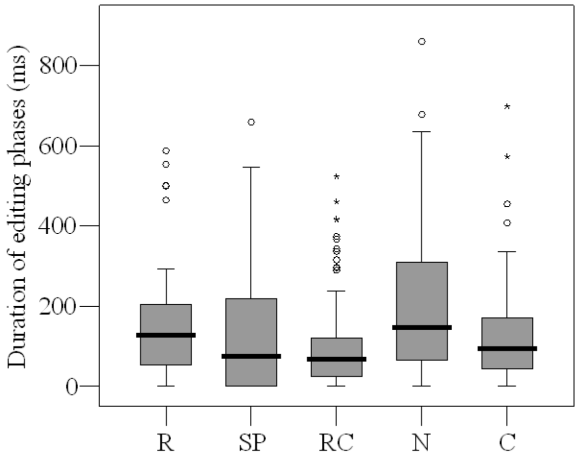

Figure 3.5. Durations of cutoff-to-repair intervals in part-word repetitions across discourse types (median and range). (R = reading, SP = sentence repetition, RC = recall, N = narrative, C = conversation.)

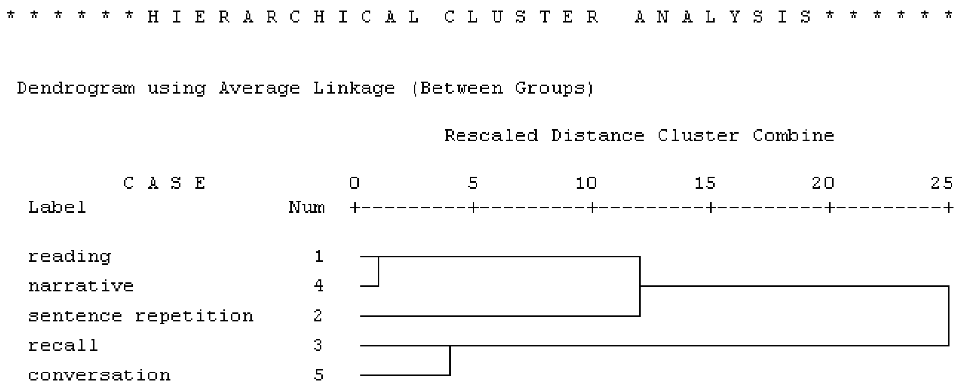

Figure 3.6. Results of hierarchical cluster analysis across discourse types considering all analyzed parameters.

The main difference between reading, sentence repetition and narrative as opposed to conversation and recall seems to lie in the different speech planning levels involved in the various discourse types.

4 Discussion

The findings of this study supported the assumption that both the incidence and the timing values of the analyzed parameters were indeed dependent on discourse type. It is worth mentioning that the aim of this study was not to analyze the stuttering level of our PWS. We investigated four types of disfluencies that were assumed to be influenced by the analyzed discourse types. There were large differences in the disfluency ratio in our PWS's speech depending on discourse type.

The least amount of time spent on disfluencies was found in reading (9.8%), followed by sentence repetition (14.2%). Out of the three spontaneous discourse types, disfluencies took up the most time in recall (28.6%); less time was spent producing disfluencies in narrative (21.8%) and the least in conversation (19.2%). However, the occurrence of disfluency types seems to be characteristic of discourse type. We will summarize some of the main facts about the occurrence and the durations of disfluencies depending on discourse type. Filled pause was less frequent in reading and sentence repetition, while it was considerably more frequent in conversation and in narrative. Filled pause was used even more frequently by our PWS in recall, suggesting that she often needed extra time for speech planning in this discourse type (Shriberg, 2001; Watanabe et al. 2008). Prolongations were not very frequent in narrative, conversation and reading, but were frequent in recall and in sentence repetition (Kleinow and Smith 2000). Word repetition did not appear very frequently in reading, and appeared hardly at all in sentence repetition. It occurred most frequently in conversation. Part-word repetitions had a slightly different distribution: they were most frequent in reading and in sentence repetition, and less frequent in the three spontaneous discourse types (Maner et al., 2000; Max and Baldwin, 2010). This finding appeared to support the assumption of a monitoring deficit (e.g., Kolk and Postma, 1997; Hartsuiker and Kolk, 2001; Vasic and Wijnen, 2005; Civier et al., 2010) when the PWS controls her covert errors or assumed errors with oversensitivity in those discourse types where she has no possibility to change or avoid certain words. Next to reading and sentence repetition, most of the part-word repetitions of our PWS occurred in recall. Filled pauses were not only most frequent, but also had the longest duration in this discourse type. Prolongations were longer than filled pauses in all the analyzed discourse types, but they were less frequent. Prolongations were longest in conversation, but least frequent. We can conclude that our PWS used primarily filled pause in spontaneous speech in order to overcome her planning difficulties.

Considering all of the data, disfluencies were most frequent and relatively long in recall, reflecting the complex speech planning processes involved in this discourse type. This claim is further supported by second word durations in word repetitions that were significantly longer than first-pronounced words in this discourse type. Our PWS seems to use the longer duration of the repeated words as a time-gaining strategy (Fox Tree, 1995; Gyarmathy, 2009). Looking at all the data in all discourse types, a careful hierarchy of task difficulty can be assumed for our speaker. Occurrence and temporal patterns of the analyzed disfluencies support the assumption that the speech tasks of reading, sentence repetition and narrative do not differ much from each other, although there are various reasons that might result in speaking difficulty. Recall and conversation were similar with respect to disfluencies, but recall showed the highest number and frequency and longest durations of disfluencies in our PWS's speech production. This conclusion was also supported by the hierarchical cluster analysis (Schwartz and Conture, 1988).

The assumption that the different tasks posed by different discourse types require different amounts of repairing time was confirmed by durational data relating to the cutoff-to-repair intervals of word repetitions and part-word repetitions. Comparing the durations of the cutoff-to-repair intervals between part-word and word repetitions, three large differences were found. The intervals in narrative were much longer in part-word repetitions than in word repetitions. This suggests that in the narrative task,our PWS needed more time for the control processes involved in part-word repetitions. On the other hand, the cutoff-to-repair intervals of word repetitions were much longer in recall and in conversation than those in part-word repetitions. This suggests that the cutoff-to-repair intervals of word repetitions were used in these discourse types for speech planning rather than for controlling the produced sound sequences.

The subjective opinion expressed by PWSs about the negative impact of stuttering in certain life situations (Craig et al., 2009) has been confirmed by objective data in our single case study. Our findings may provide a better insight into the inner control and detection of planning failures, as well as their attempted repair in stuttering, a topic worth further study. We have to emphasize that our study is an inherently “weaker” research design and limits the ability to generalize findings to the population at large. However, we think that it is worth analyzing the effect of various discourse types on PWS’ speech involving more participants. The present findings are expected to add something to the discourse type effect measurements on fluency level of a PWS using natural, typical disfluency phenomena. Data for more individuals could be used in multidimensional assessment and treatment of stuttering.

5 Acknowledgements

We would like to thank Dr. Pál Heltai and András Beke for their help in preparing this paper and two anonymous referees for their helpful comments on the earlier versions of the text. This work was supported by the OTKA project No. 78315.

References

Bajaj, A. 2007a. Analysis of oral narratives of children who stutter and their fluent peers: Kindergarten through second grade. *Clinical Linguistics & Phonetics*, 21, 227–245.

Bajaj, A. 2007b. Working memory involvement in stuttering: Exploring the evidence and research implications. *Journal of Fluency Disorders*, 32, 218–238.

Blomgren, M. A. and Goberman, M. 2008. Revisiting speech rate and utterance length manipulations in stuttering speakers. *Journal of Communication Disorders*, 41, 159–178.

Bloodstein, O. 1993. *Stuttering: The search for a cause and cure*. Boston: MA: Allyn and Bacon.

Boersma, P. and Weenink, D. 2004. *Praat: doing phonetics by computer* (version 4.4). http://www.praat.org./ (September, 18, 2005).

Bóna, J. 2008. The characteristics of prolongations in stuttering and non-stuttering speech. *Beszédkutatás*, 148–56 (in Hungarian).

Bóna, J. and Imre, A. 2010. How do Hungarian adults read aloud? In M. L. Dionísio, J. A. Brandao, R. de Carvalho, V. Castro (Eds.), *Discovering worlds of literacy: Proceedings of the 16th European conference on reading and 1st Ibero-American forum on literacies*. Braga: University of Braga. (CD-ROM)

Borsel van, J. and Taillieu, C. 2001. Neurogenic stuttering versus developmental stuttering: An observer judgement study. *Journal of Communication Disorders*, 34, 385–395.

Bortfeld, H., Leon. S. D., Bloom, J. E., Schober, M. F. and Brennan, S. E. 2001. Disfluency rates in conversation: Effects of age, relationship, topic, role and gender. *Language and Speech*, 44, 123–47.

Bosshardt, H. G. 1997. Mental effort and speech fluency. In W. Hulstijn, H. F. M. Peters, P. H. H. M. Lieshout van (Eds.), *Speech production, motor control, brain research and fluency disorders* (pp. 503–514). Amsterdam: Elsevier.

Brocklehurst, P. H. 2008. A review of evidence for the covert repair hypothesis of stuttering. *Contemporary Issues in Communication Science and Disorders*, 35, 25–43.

Burger, R. and Wijnen, F. 1999. Phonological encoding and word stress in stuttering and nonstuttering subjects. *Journal of Fluency Disorders*, 24, 91–106.

Civier, O. Tasko, S. M. and Guenther, S. H. 2010. Overreliance on auditory feedback may lead to sound/syllable repetitions: Simulations of stuttering and fluency-inducing conditions with a neural model of speech production. *Journal of Fluency Disorders*, 35, 246–279.

Craig, A., Hancock, K., Chang, E., McCready, C., Shepley, A. and McCaul, A. 1996. A controlled clinical trial for stuttering in persons aged 9 to 14 years. *Journal of Speech and Hearing Research*, 39, 808–826.

Craig, A., Hancock, K. and Craig, M. 1996. The lifestyle appraisal questionnaire: A comprehensive assessment of health and stress. *Psychology and Health*, 11, 331–343.

Craig, A., Blumgart, E. and Tran Y. 2009. The impact of stuttering on the quality of life in adults who stutter. *Journal of Fluency Disorders*, 34, 61–71.

Curlee, R. F. 2004. Stuttering. In R. D. Kent (Ed.), *The MIT Encyclopedia of Communication Disorders* (pp. 220–223). Cambridge, Massachusetts: MIT Press.

Fox Tree, J. 1995. The effects of false starts and repetitions on the processing of subsequent words in spontaneous speech. Journal of Memory and Language 34, 709-738.

Ginsberg, A. P. 2000. Shame, self-consciousness, and locus of control in people who stutter. *The Journal of Genetic Psychology*, 161, 389–399.

Gahl, S. 2008. Time and thyme are not homophones: the effect of lemma frequency on word durations in spontaneous speech. *Language*, 84, 474–496.

Gósy, M. 2003. Co-occurrences and frequency of disfluencies in Hungarian spontaneous speech. *Govor*, 20, 79–97.

Gyarmathy, D. 2009. Analysis of the speaker's repetitions and part-word repetitions. *Beszédkutatás*, 196–216 (in Hungarian).

Hartsuiker, R. J. and Kolk, H. H. J. 2001. Error monitoring in speech production: A computational test of the perceptual loop theory. *Cognitive Psychology*, 42, 113–157.

Healey, Ch. E., Trautman, L. S. and Susca, M. 2004. Clinical applications of a multidimensional approach for the assessment and treatment of stuttering. *Contemporary Issues in Communication Science and Disorders*, 31, 40–48.

Horváth, V. 2010. Filled pauses in Hungarian: Their phonetic form and function. *Acta Linguistica Hungarica*, 57, 288–306.

Howell, P. 2007. A model of serial order problems in fluent, stuttered and agrammatic speech. *Human Movement Science*, 26, 728–741.

Howell, P., Sackin, S., Glenn, K. and Au-Yeung, J. 1997. Automatic stuttering frequency counts. In W. Hulstijn, H. F. M. Peters and P. H. H. M. van Lieshout (Eds.), *Speech production, motor control, brain research and fluency disorder* (pp. 395–404). Amsterdam: Elsevier.

Howell, P., Au-Yeung J. and Sackin, S. 1999. Exchange of stuttering from function words to content words with age. *Journal of Speech, Language, and Hearing Research*, 42, 345–354.

Howell P. and Dworzynski, K. 2005. Planning and execution processes in speech control by fluent speakers and speakers who stutter. *Journal of Fluency Disorders*, 30, 343–354.

Howell, P., Au-Yeung, J., Yaruss, S. J. and Eldridge, K. 2006. Phonetic difficulty and stuttering in English. *Clinical Linguistics and Phonetics*, 20, 703–716.

ICD 2007. *International statistical classification of diseases and related health problems* (10th revision). http://www.who.int/classifications/apps/icd/icd10online. (Retrieved: March 12, 2011.)

Irwin, M. 2006. Terminology – how should stuttering be defined and why? In J. Au-Yeung and M. M. Leahy (Eds), *Research, treatment, and self-help in fluency disorders: New horizons* (pp. 41–45). Dublin: The International Fluency Association.

Kelly, E. M. 2000. Modeling stuttering etiology: Clarifying levels of description and measurement. Journal of Fluency Disorders 25, 359–368.

Kleinow, J., & Smith, A. 2000. Influences of length and syntactic complexity on the speech motor stability of the fluent speech of adults who stutter. *Journal of Speech, Language, and Hearing Research*, 43, 548–559.

Kolk, H. and Postma, A. 1997. Stuttering as a covert repair phenomena. In R. F. Curlee and G. M. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (pp. 182–203). Needham Heights, MA: Allye and Bacon.

Lajos, P. 2003. *On stuttering for everybody*. Budapest: Pont Kiadó (in Hungarian).

Levelt, W. J. M. 1989. *Speaking: From intention to articulation*. Cambridge MA, London: A Bradford Book, The MIT Press.

Lieshout, P. H. H. M. van, Peters, H. F. M, Starkweather, W. C. and Hulstijn, W. 1993. Physiological differences between stutterers and nonstutterers in perceptually fluent speech: EMG amplitude and duration. *Journal of Speech and Hearing Research*, 36, 53–63.

Logan, K.J., Byrd, C.T., Mazzocchi, E.M., & Gillam, R.B. 2011. Speaking rate characteristics of elementary-aged children who do and do not stutter. *Journal of Communication Disorders*, 44, 130–147.

Logan, K.J. and Conture, E. 1995. Length, grammatical complexity, and rate differences in stuttered and fluent conversational utterances of children who stutter. *Journal of Fluency Disorders*, 20, 35-61.

Maner, K. J., Smith, A. and Grayson, L. 2000. Influences of utterance length and complexity on speech motor performance in children and adults. *Journal of Speech, Language and Hearing Research*, 43, 560–573.

Max, L. and Baldwin, C. J. 2010. The role of motor learning in stuttering adaptation: Repeated versus novel utterances in a practice–retention paradigm. *Journal of Fluency Disorders*, 35 (2010) 33–43.

Parry, W. D. 2009. *Understanding and controlling stuttering*. New York: National Stuttering Association.

Perkins, W. H. 1995. *Stuttering and science*. San Diego, CA: Singular Publishing Group.

Pochman, A. and Attanasio, J. S. (Eds). 2007. *Theoretical issues in stuttering*. Cornwall: Psychology Press.

Polyna, S. M., Norman, K. A. and Kahanaa, M. J. 2009. Task context and organization in free recall. Neuropsychologia, 47, 2158–2163.

Postma, A. and Kolk, H. 1993. The covert repair hypothesis: Prearticulatory repair processes in normal and stuttered disfluencies. *Journal of Speech and Hearing Research*, 36, 472–487.

Ratner, N. B. 2005. Is phonetic complexity a useful construct in understanding stuttering? *Journal of Fluency Disorders*, 30, 337–341.

Riley, G. D. 1994. *Stuttering Severity Instrument for children and adults*. (SSI-3). Austin: TX: Pro-Ed.

Roberts, P. M., Meltzer, A. and Wilding, J. 2009. Disfluencies in non-stuttering adults across sample lengths and topics. *Journal of Communication Disorders*, 42, 414–427.

Schwartz, H., & Conture, E. 1988. Subgrouping young stutterers. Journal of Speech and Hearing Research, 31, 62–71.

Scott, L. A., Healey, Ch. E. and Norris, J. A. 1995. A comparison between children who stutter and their normally fluent peers on a story retelling task. *Journal of Fluency Disorders*, 20, 279–292.

Shriberg, E. 2001. To 'errrr' is human: Ecology and acoustics of speech disfluencies. *Journal of the International Phonetic Association*, 31, 153–169.

Smith, A. 1997. Dynamic interactions of factors that impact speech motor stability in children and adults. In W. Hulstijn, H. F. M. Peters and P. H. H. M. Lieshout van (Eds.), *Speech production, motor control, brain research and fluency disorders* (pp. 143–150). Amsterdam: Elsevier.

Smith, A. 1999. Stuttering: a unified approach to a multifactorial, dynamic disorder. In B. N. Ratner and C. E. Healey Eds.), *Stuttering research and practice*. Bridging the Gap (pp. 27–44). Mahwah, New Jersey: Erlbaum.

Smith, A. and Kelly, E. 1997. Stuttering: a dynamic, multifactorial model. In R. F. Curlee and G. M. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (pp. 204–217). Needham Heights, MA: Allye and Bacon.

Smith, A., Sadagopan, N., Walsh, B. and Weber-Fox, C. 2010. Increasing phonological complexity reveals heightened instability in inter-articulatory coordination in adults who stutter. *Journal of Fluency Disorders*, 35, 1–18.

Starkweather, C. W. and Gottwald, S. R. 1990. The demands and capacities model II: Clinical applications. *Journal of Fluency Disorders*, 15, 143–157.

Tani, T. and Sakai, Y. 2011. Analysis of five cases with neurogenic stuttering following brain injury in the basal ganglia. *Journal of Fluency Disorders*, 36, 1–16.

Tetnowski, J. A. and Damico, J. S. 2001. A demonstration of the advantages of qualitative methodologies in stuttering research. *Journal of Fluency Disorders*, 26, 17–42.

Trautman, L. S, Healey, E. C., Brown, T. A., Brown, P. and Jermano, S. 1999. A further analysis of narrative skills of children who stutter. *Journal of Communication Disorders*, 32, 297–315.

Yairi, E. 2007. Subtyping stuttering I: A review. *Journal of Fluency Disorders*, 32, 165–196.

Vasic, N. and Wijnen, F. 2005. Stuttering as a monitoring deficit. In R. J. Hartsuiker, R. Bastiaanse, A. Postma, F. Wijnen (Eds.), *Phonological encoding and monitoring in normal and pathological Speech* (pp. 226–247). Hove, New York: Psychology Press.

Wall, M. J., Starkweather, W. C. and Cairns, H. S. 1981. Syntactic influences on stuttering in young child stutterers. *Journal of Fluency Disorders*, 6, 283–298.

Wingate, M. E. 1988. *The structure of stuttering: A psycholinguistic perspective*. New York: Springer.

Watanabe, M., Keikichi, H., Yasuharu D. and Nobuaki M. 2008. Filled pauses as cues to the complexity of upcoming phrases for native and non-native listeners. *Speech Communication*, 50(2), 81–94.